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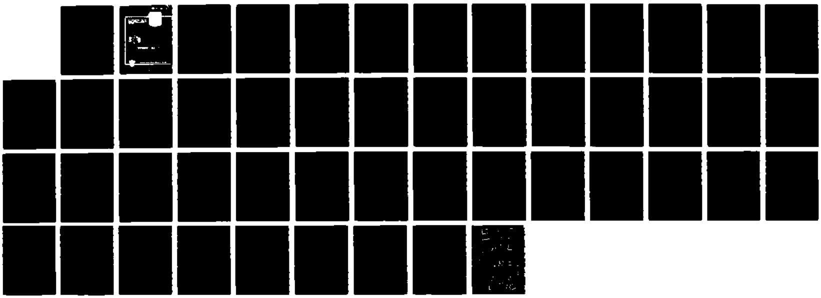

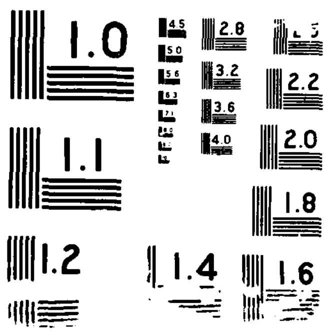
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RATIONAL FRAMEWORK FOR REALLOCATING DEVELOPMENT AND ACQUISITION FUNDS

BY

DR. PAUL E. EHLE

30 MARCH 1988

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

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The Army is entering a difficult era where funding turbulence and decrements will likely become more common while missions remain unchanged or even grow. In this environment, maximizing the benefit from each dollar for materiel development and acquisition will become increasingly important. This study produces a general framework that can be used to increase rationality and effectiveness in the reallocation of funds. The proposed system approach is based on development and selection of guiding principles, analysis tools, and

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ABSTRACT--continued.

evaluation criteria that are tailored to the particular circumstances of a given reallocation exercise. The basic message in this paper is the need for specialized principles to guide materiel funding; the need for a structure to promote systematic construction and evaluation of funding alternatives; the need to know impacts and interrelations of funding changes; and the potential of modern analysis tools to help with these problems. A simple reprogramming problem is demonstrated in the context of the proposed framework. This example is further used to show the power and applicability of mathematical optimization tools. Finally, implementation considerations are explored, conclusions are drawn and recommendations are made.

USAWC MILITARY STUDIES PROGRAM PAPER

RATIONAL FRAMEWORK FOR REALLOCATING DEVELOPMENT AND ACQUISITION FUNDS

AN INDIVIDUAL STUDY PROJECT

by

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ABSTRACT

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RATIONAL FRAMEWORK FOR REALLOCATING DEVELOPMENT AND ACQUISITION FUNDS

CHAPTER I

INTRODUCTION

As a member of the Army Research, Development and Acquisition community, the author has participated in numerous funding decrement exercises. These were conducted at Department of Army (DA), Army Materiel Command (AMC), and Major Subordinate Command (MSC) levels. What they all lacked was the application of a rational methodology with which to structure a revised overall program clearly focused on maximizing the use of remaining resources to deter or win future wars. Some of the reallocation decisions were largely arbitrary or politically driven. Others were optimized on a narrow basis, with little information on broad impacts including cumulative impacts from preceding exercises. This paper is an attempt to foster progress toward a more rational alternative.

As used here, the term "rational" refers to the auditable application of logic, structure, objectivity and analysis to the attainment of well-defined goals. The approach pursued in this paper could be realistically termed "quasi-rational" in recognition that a totally rational alternative would likely be impractical in the extremely complex and political world of materiel acquisition. The philosophy followed is to increase rationality where possible and appropriate and to blend in subjective information and evaluation where necessary.

Reallocation of funding resources is likely to become an increasingly important exercise as Army dollars shrink or remain constant while Soviet capabilities continue to grow. This reallocation must take place in a very

difficult and turbulent environment that tends to hinder rational analysis. In fact, a serious question can be raised (and addressed at the end of this chapter) as to whether or not trying to apply any but the broadest levels of logical structure to the reallocation problem is futile in this environment.

STUDY OBJECTIVE

The objective of this study is to develop a broad, flexible, logical and practical framework that could be used at DA and MACOM levels to improve the process of reallocating funds for development and acquisition of materiel.

SCOPE OF STUDY

This paper is aimed at refinement of one relatively narrow but critical aspect of the Army Planning, Programming, Budgeting, and Execution System (PPBES). Reallocation rather than allocation of materiel resources is selected for this short study partly because it is potentially a narrower problem. For example, one possible option is simply to "salami slice" the previously established program, which means each funding line is assessed a proportional share of the overall decrement. Another reason for selecting reallocation is that it often receives less objective attention than it deserves, given the magnitude of funds involved.

Funds under primary consideration in this paper include those for Advanced Development (funding category 6.3B), Engineering Development (funding category 6.4) and Procurement. This focus reflects the view that the technology base (funding categories 6.1, 6.2, 6.3A) requires fundamentally different evaluation criteria and that changes in development and acquisition funds normally have relatively weak influence on the structure of the technology base. Changes in

the technology base, however, can strongly affect development and acquisition; and impacts passing through the interface in this direction must be closely monitored and coordinated. Similarly, as shown in Fig. 1-1, changes in Operations and Maintenance-Army (OMA) and Military Construction-Army (MCA) funds

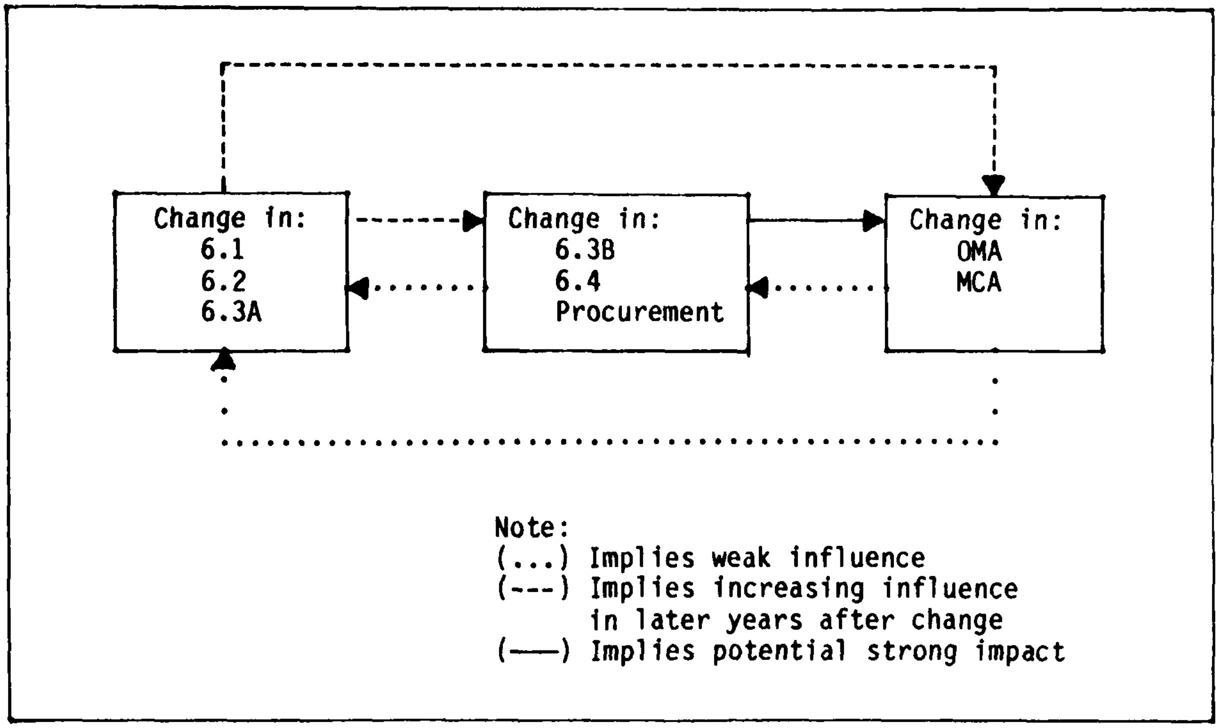

Figure 1-1. Reallocation Interfaces by Funding Category

normally only weakly affect development and acquisition programs. The latter programs are justifiably the "drivers" due to their role in fulfilling formal user requirements. However, changes in development and acquisition can greatly impact support and construction, and these effects need to be reflected in OMA and MCA plans. Therefore, a reasonable simplification is to suboptimize over development and acquisition funds and separately and iteratively deal with the interfaces. This approach appears to be more practical, at least in the near term, than trying to "juggle" simultaneously all programs from all funding

categories, which is recommended as a long-term goal.

Finally, the intended levels for application of this methodology are Major Army Command (MACOM) and Department of Army (DA). Higher and lower organizational levels have significantly different breadths of focus. Nevertheless, some elements of the methodology may also have application at these other levels.

LITERATURE OVERVIEW

A review of management books, government publications and other sources uncovered relatively little information specifically aimed at how to approach a funding decrement problem. Perhaps the book that came the closest in spirit is titled Managing for Negative Growth.[1] It is, however, focused on problems of retrenchment in commercial industry, with very little obvious applicability to government and military. One of the most enlightening sources is Planning Programming Budgeting - A Systems Approach to Management.[2] This book provides insight into the historical development of PPBES, basic economic principles, systems analysis and other topics relevant to the reallocation problem. Some of the specific information is now outdated, but its general ideas remain valid. Much of the government-published discussion of planning, programming and budgeting concerns organizations, responsibilities and administrative procedures rather than theory and philosophy. Many sources exist concerning the basis of rational decision making, but these are not made explicit for the reallocation problem. Much information is available for certain analysis tools, such as mathematical optimization. Nick Kotz's recent book, Wild Blue Yonder [11] is an excellent introduction to the political aspects of defense spending. In general, the most valuable sources of information for this study were the

speakers, seminar discussions, exercises and wide range of military readings that were part of the curriculum for the Class of 1988 at the US Army War College. The author viewed each speech, discussion, exercise and reading in terms of whether anything said or written might have a bearing on the realloca- tion problem. Many of the considerations so filtered out were generalized and reflected in various elements of the proposed framework.

SOURCES AND IMPORTANCE OF THE REALLOCATION PROBLEM

At DA and MACOM levels, reallocation exercises arise frequently and from many different sources. For example, in program execution years, unanticipated bills often result from technical problems, procurement cost overruns and threat growth. In the budget-year program, Congress may significantly reduce the anticipated funding level; and ripple effects on future years must be established. Also, fluctuations in Department of Defense (DOD) funding guidance can necessitate revised plans, often within short timeframes. Frequently the exercise may be driven by a decision that Research, Development, Test and Evaluation (RDTE) and Procurement accounts will pay a given percentage of an overall Army bill or decrement.

Army funding trends are now out of step with the quantity and quality of the Soviet military buildup.[3,4] This fact will make even more critical the need to extract the greatest possible benefit from each available dollar. Making wise choices in adjusting which and how much materiel to buy can play a significant role in minimizing the impacts of funding decrements.

ENVIRONMENT

Surrounding the development and acquisition of materiel is a highly

volatile environment. In this environment, threat assessments constantly change, new technologies arise as others are rendered obsolete and news media continually search for issues that sometimes precipitate great pressures on the acquisition process. With large fluctuations in funding levels from year to year, some programs are started, virtually stopped and then restarted,[5] usually at great loss in efficiency.

The environment is also competitive, parochial, political and racked by conflicting pressures. A program can either be funded or terminated according to the talents, positions and efforts of its supporters. There are many opportunities throughout the PPBES to advance or derail programs according to individual agendas. Often little discipline exists within the Army to rally behind a contentious decision no matter at what level it is made. On the Congressional side, job security for constituents is sometimes placed above the national interest [11]. At the same time, many other conflicting pressures push and pull on the development and acquisition process. These include near-term readiness vs. sustainability vs. future hardware, offense vs. defense, "tooth" vs. "tail," tanks vs. helicopters, quantity vs. quality, most serious threat vs. most likely threat, need vs. affordability and deterrence vs. warfighting.

The environment is extremely complex. There are more than 2,000 development and acquisition Program Elements (PE's) and procurement budget lines (SSN's) combined into hundreds of Program Development Increment Packages (PDIP's). Many interdependencies not readily apparent exist among programs, so that elimination of a seemingly low priority program could have severe consequences for a high priority effort or for an important functional balance. Particularly difficult is the problem of clearly establishing individual programs as necessary and the overall collection of programs as sufficient to

accomplish broad goals and success in warfighting. Inability to do this rationally and convincingly invites political slicing of national and DOD money "pies" rather than funding of what is actually needed for defense.

Other difficult characteristics of the environment include ingrained preoccupation with the short term, "eaches"[6] and micromanagement orientation at all levels including Congress, uncertainty, ambiguity, insufficient time for in-depth analysis of issues, and excessively long acquisition cycles.

RATIONALITY vs. REALITY

A case can be made that efforts to increase PPBES rationality through refinements in structure and analysis are a waste of time and money. This viewpoint stems from the assertion that there is the PPBE System and then there is the "real system."[7] The latter is based on personalities, biases, and high-level "seat-of-the-pants" decisions and, in fact, controls most resource allocations and reallocations. The "real system" is unstructured in contrast to the PPBES, which is highly structured. The structured system is "an integrated, logical and systematic way of stating objectives, requirements, plans, programs and budgets."[8] "The unstructured system is characterized by bartering, compromise and accommodation. Issues are cast not only in terms of ability to contribute to readiness or sustainability, but also in terms of contribution to the basic 'equity of resource distribution.'"[9] The unstructured system "arose because the structured system was not able to provide timely, acceptable solutions to problems involving competition between vastly different demands. The structured system is not able to quantify the 'value' of each competitor for the overall resources."[10] It can be argued that the primary contribution of the structured system is to provide "the framework in which the unstructured

system operates."[11]

Assuming that the structured system is so overshadowed, why expend great effort to improve and refine it? One reason is that the stakes are too high to accept the status quo. With the continuing growth of Soviet power, the margin of error has been virtually eliminated; and consequences of peacetime planning mistakes are potentially disastrous to the nation. Another reason is that prospects for significantly enhancing the ability of the unstructured system to deal with this situation appear to be slight compared to development potential for the structured system. Significant improvements to the structured system, particularly in the areas of defensibly quantifying relative value of resource competitors and accurately predicting impacts of funding decisions, would reduce rationale for and tenability of primary reliance on the unstructured system. Clearly there is difficulty in accomplishing such improvements, but no fundamental obstacle to doing so appears to exist. The unstructured system may never be totally eliminated (and probably should not be), but nonrationality in the expenditure of large amounts of Army resources is both dangerous and unnecessary. This paper is aimed at demonstrating one way that increased rationality in the structured system is both possible and worthwhile.

ENDNOTES

1. Allan Easton, Managing for Negative Growth, pp. 3-169.

2. Fremont J. Lyden and Ernest G. Miller, eds., Planning Programming Budgeting - A Systems Approach to Management, pp. 1-423.

3. Fred C. Ikle, et al., Discriminate Deterrence - Report of the Commission on Integrated Long-Term Strategy, p.28, pp. 45-69.

4. Benjamin F. Schemmer, "An Exclusive AFJ Interview With: Phillip A. Karber," Armed Forces Journal International, p. 120.

5. Nick Kotz, Wild Blue Yonder, p.8.

6. "Eaches" refers to systems considered separately and individually, with little or no consideration given to relationships with other systems.

7. David Pearce, "The PPBE System and the Real System," Resource Management, pp. 17-18.

8. Pearce, p. 17.

9. Pearce, p. 17.

10. Pearce, p. 17.

11. Pearce, p. 18.

CHAPTER II

BROAD PERSPECTIVES

Materiel, which is at the focus of this paper, is only one of the important factors in deterring or winning wars. Despite difficulties, it is one of the most analyzable. Working from known general approaches to the broad problem of force planning, one can develop a reasonable set of guiding principles for use in the narrower problem of planning materiel development and acquisition.

FACTORS IN WINNING WARS

Battlefield success is dependent upon many interrelated factors. One can find historical examples to justify the following as being potentially important to the outcome of battles and wars:

- Leadership
- Materiel
- Morale
- Organization
- Doctrine
- Training/experience
- Strategy/operational art/tactics
- Manpower
- Scenario
- Alliances
- National will
- Military intelligence
- Weather
- Terrain
- Luck
- Other

Reliable analysis of all the complex interrelationships among these factors is not now (and may never be) possible. However, from the above list, the following appear to be amenable to useful and steadily improvable analysis, particularly through computer simulations:

- Materiel
- Organization
- Doctrine
- Strategy/operational art/tactics
- Manpower
- Scenario
- Weather
- Terrain

The composition of and interrelationships among these factors are normally established through the force planning process. At least eight basic approaches to force planning have been conceptualized by others and may be used indi-

vidually or in combination. They are:[1]

- Top-down
- Bottom-up
- Scenario
- Threat
- Mission
- Hedging
- Technology
- Fiscal

The "top-down" approach emphasizes tailoring the force so that it can implement objectives and strategy/operational art/tactics established by a hierarchy of decision-makers. In contrast, the "bottom-up" approach typically reflects near-term capabilities needed by the operational Commanders in Chief (CINC's). The "scenario" approach leads to a force structure that is optimized for a specific set of circumstances, while the "threat" approach is reactive to and focused on projected enemy capabilities. The "mission" approach is concentrated on balances across broad warfighting functions. "Hedging" is pursuit of flexibility to meet a variety of contingencies, and technological force multipliers are sought through the "technology" approach. Finally, the "fiscal" approach is designed to maximize the capabilities obtainable from dollar levels imposed strictly from balances such as defense vs. other elements of the economy or materiel vs. personnel.

Strengths and weaknesses of each of these approaches when used independently are well documented.[2] For example, the "bottom-up" approach tends to emphasize current reality but at the expense of future capabilities. However, it can provide balance to the "top-down" approach, which has the opposite effect. Skillfully combining approaches may reduce many of the negatives while aggregating the positives.

Through the combination of the "threat" and "scenario" approaches for specific cases of organization, doctrine, strategy/operational art/tactics, manpower, scenario, weather and terrain, materiel options can be rationally evaluated on the basis of the following US/enemy comparisons:

- System against system (same or different type)
- Function against function (same or different type)
- Technology against technology (same or different type)
- Unit against unit (same or different type)
- Force against force (same or different type)

Results of such threat-and-scenario-based comparisons can then be expressed as both US and enemy materiel deficiencies, which form the basis for the first two proposed Guiding Principles in Table 2-1.

By extrapolation from this and other combinations of force planning approaches, one can develop a reasonably comprehensive set of guiding principles for materiel development and acquisition.

PROPOSED GUIDING PRINCIPLES

A set of sixteen principles shown in Table 2-1 is proposed by the author as a rational basis for both allocation and reallocation of development and acquisition funding. Specific interpretation of the meaning of the terms "serious," "adequate," etc. in these principles is left to military judgment of senior leaders under prevailing circumstances. Where quantifiable, they can be incorporated as numerical factors in tools used to develop funding options.

Currently, the major materiel focus of PPBES is on the first principle, which is to identify and correct US materiel deficiencies. Such deficiencies are established in the Battlefield Development Plan (BDP) [26],[27]. However, too much concentration on deficiencies relative to enemy equipment can lead to an undesirable and subtle bias in the overall program toward reaction rather than proaction. Relatively little emphasis is placed on the second principle, which is to identify and exploit Soviet weaknesses. The US Army Intelligence Agency publishes in five volumes a Soviet Battlefield Development Plan (SBDP) [24]. Just as the Training and Doctrine Command (TRADOC) develops a prioritized

1. Identify and correct the most serious US materiel deficiencies.

2. Identify and exploit Soviet materiel deficiencies when it is cost effective and affordable to do so.

3. Identify and exploit enduring US strengths vs. Soviet weaknesses ("Competitive Strategies").

4. Identify and exploit cost effective and affordable areas where increased US capabilities can provide disproportionally large advantages over the Soviets or require costly countermeasures.

5. Identify and exploit cost-effective and affordable technology specifically aimed at saving money.

6. Focus materiel efforts through specific goals and objectives wherever these can be rationally defined.

7. Increase quality and warfighting effectiveness of Army materiel on a functional rather than solely "eaches" basis, to include other service contributions.

8. Provide sufficient flexibility to meet contingencies and obviate planning errors made in a highly uncertain environment.

9. Maintain a consistently balanced overall program (or carefully control asymmetries).

10. Conserve funds through good business/management practices.

11. Have all materiel necessary to win, with a high degree of certainty, under the most likely scenarios and deter under the most threatening.

12. Keep the yearly balance between near-term readiness and long term capabilities in step with the most likely projected threats.

13. Maintain a viable production base with adequate surge and sustainment to win with a high degree of certainty under the most likely scenarios.

14. Suboptimize capabilities at the broadest possible levels where reliable results are obtainable.

15. Implement Rationalization, Standardization and Interoperability (RSI) that is cost-effective and affordable among allied systems, sister-service systems, and Army systems.

16. Tailor, augment and prioritize application of these principles based on current top-level military judgment.

Table 2-1. Proposed Guiding Principles

list of deficiencies associated with the US BDP[3], the same could be done for the SBDP. Once these Soviet deficiencies are identified, materiel options could be developed to exploit them. The idea is that, rather than concentrating almost exclusively on US deficiencies, the Army should also determine Soviet materiel deficiencies and actively work to exacerbate them.

The next step in this paper is to propose a framework, within the PPBES, where these or similar principles can be used to help solve reallocation problems. Such principles should be reviewed periodically to insure their continued compatibility with national strategy and high-level guidance.

ENDNOTES

1. Richmond M. Lloyd and Dino A. Lorenzini, "A Framework for Choosing Defense Forces," Naval War College Review, Jan-Feb 1981, pp. 46-58.

2. Lloyd and Lorenzini, pp. 46-58.

3. US Army Training and Doctrine Command, TRADOC Regulation 11-15, p. 2-9.

CHAPTER III

PROPOSED FRAMEWORK

The proposed framework for reallocation of funds consists of a system model driven by Guiding Principles (Table 2-1) and amplified by menus of subsystem elements. Selectability of these elements via menus serves to create flexibility to meet unique and evolving circumstances surrounding materiel development and acquisition. A first-level menu is provided in this chapter for each block in the system model, and a second-level menu for one of the key subsystems is included in Appendix 1. (Menu "level" refers degree of detail, "second" being more detailed than "first.") A simple example is provided to illustrate one way in which the framework can be used. In addition, one of the important but often neglected tools, mathematical optimization, is further explored as a continuation of the example.

SYSTEM MODEL

One rational way to attack reallocation problems is through a systems analysis approach. A proposed system model including blocks for input, tailoring, process, output, review and decision is shown in Fig. 3-1.

The heart of the framework is the "process" block that includes the use of subsystems of tools and evaluation criteria to develop reasonable options. As can be seen, much interaction occurs among the three component subsystems of this block.

Three feedback loops resulting from review of alternative/recommended options can be directed at modification of the basic input information, retailoring of the process itself, or evaluation of modified options. These loops enhance the involvement of key personnel and use of their military judgment.

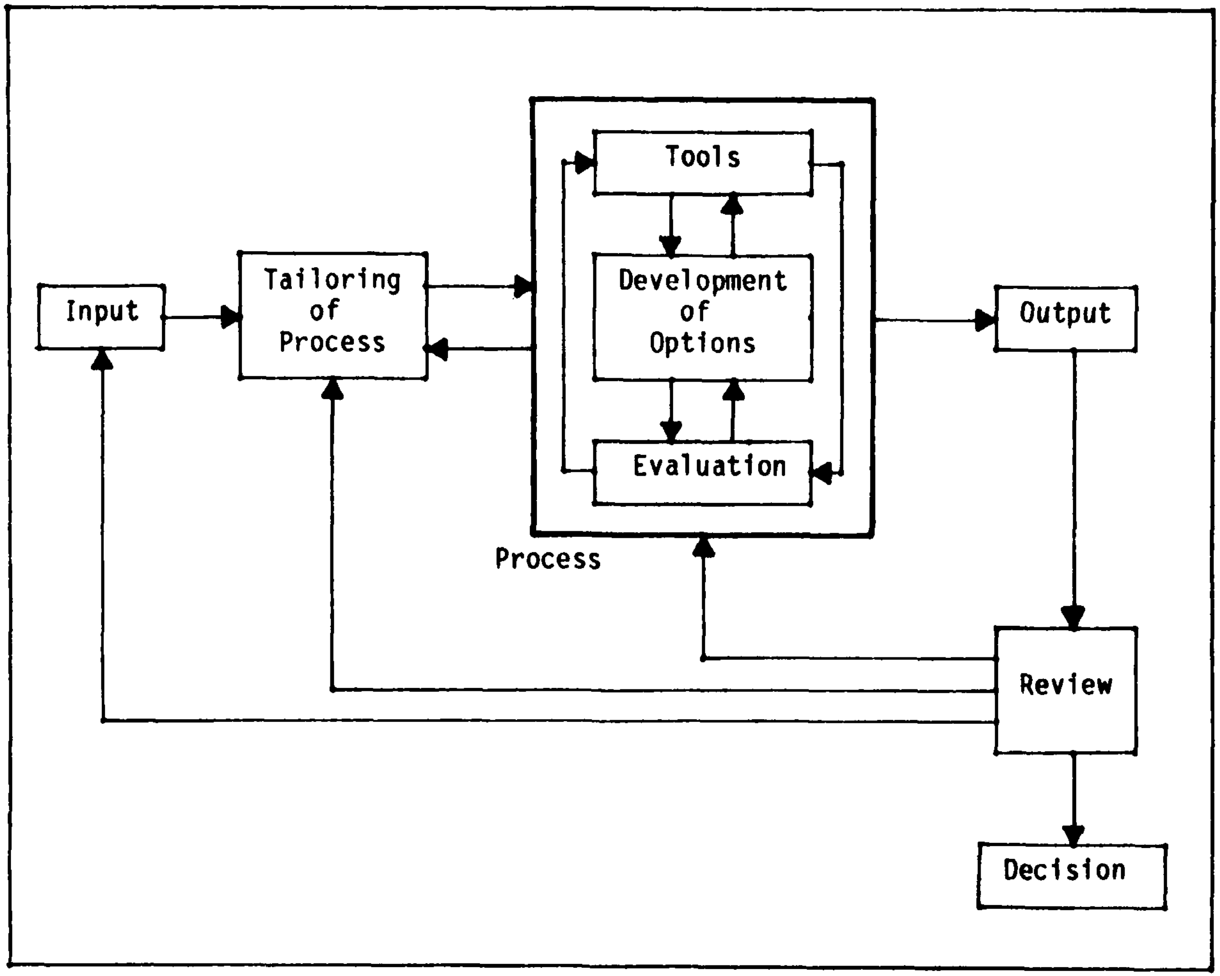

Figure 3-1. Proposed Systems Model for Reallocation Framework

Many ways exist to construct and implement such a system. A unique possibility is to view the reallocation problem as being analogous to the selection of officers for promotion. Selecting programs to fund has many similarities to selecting officers to promote. Tools and procedures from the Army's new highly automated Selection Board Support System (SBSS) might contain elements adaptable to the development and procurement process. A similar mechanism involving boards, panels, criteria, automation and top-level guidance to participants could be instituted for funding reallocation. In fact, a number

of resource boards and panels already exist. In analogy to the criteria for officer promotion, past performance of programs could be rated, quotas on certain types of programs could be imposed and timely accomplishment of certain milestones ("gates") could be evaluated. Such an approach maximizes human interaction and collective judgment and mixes subjectivity with objectivity.

A second approach is to use Artificial Intelligence (AI) to replicate the thought processes of idealized human experts or panels. Comprehensive databases and "expert system" software would be required. One would need to establish decision rules to generate and evaluate alternatives automatically. This approach would not be limited to quantifiable considerations, necessary subjectivity could be incorporated in the rules, and the rules could be routinely modified to reflect the basic philosophy of the current decision-maker. Continuing developments in the state of the art in Artificial Intelligence can be expected to make this method increasingly feasible. Improved AI tools can be incorporated into the proposed framework as they become available.

A third approach is to formulate reallocation as a mathematical optimization problem. This method is highly amenable to automation and would result in a solution that is "optimum" in some quantifiable sense. However, because not all considerations are reliably or easily expressible as numbers, this approach should be used in combination with other tools. It is explored in some detail at the end of this chapter.

Hybrids of these and other approaches are also possible within the system framework outlined. Based on unique circumstances of time, problem scope, required degree of detail and state of the art in tool capabilities, decision-makers and staff can assemble their own subsystems from menus of elements provided in this paper.

FIRST-LEVEL MENUS

First-level menus of elements for the various blocks in the system model are presented in the next two tables. One may select any, all, or even none in each category to achieve the most appropriate mix of quantitative and human/qualitative elements for a given reallocation problem. Table 3-1 portrays most of the blocks for the systems model. Table 3-2 details the all-important "process" block, with subsystems of tools, evaluation criteria and methodologies with which to develop options. This block can be considered the "center of gravity" of the entire framework. The "evaluation" menu from this block is amplified as the Level 2 menu of Appendix 1.

In Table 3-1, the "input" menu provides options for basic information necessary to understand and begin to attack the reallocation problem at hand. One chooses the appropriate elements and ignores the rest. However, the more elements selected, the greater the opportunity for wise decisions. The "tailoring" menu provides detailed guidance for use of menu items that have been selected within the "process" block. In a sense, there is an implied up-front tailoring of the entire framework at the time menu items are selected from each block. This occurs prior to use of the "tailoring" menu shown, which does not involve making initial menu selections. The "output" menu offers either alternatives or recommendations for reallocation in addition to detailed information that supports these options. The "review" menu consists of a list of people who potentially should be involved in providing military judgment to the tentative results. Finally, the "decision" menu provides various options that can be followed in bringing the exercise to a productive conclusion.

INPUT

-Objectives of reallocation exercise
-Dollars to be decremented in:
  .Total Obligation Authority
  .Specific PDIP, PE, SSN
  .Broad functional area
-Fiscal years affected
-"Guiding Principle" priorities
-Strategy for conducting exercise
  .Preserve current balances
  .Minimize negative impacts
  .Maximize resolution of US deficiencies
  .Base on selected "Guiding Principles"
-Identification of decision-maker, exercise leader & participants
-Weights for evaluation criteria
-Constraints on exercise
  .Balances to be maintained
  .Specific impacts to minimize
  .Time available for exercise
  .Political
  .Coordination required
  .Untouchable ("fenced") funds

TAILORING

-Guidance for using:
  .Tools
  .Evaluation criteria
  .Method to generate options
-Where use numbers and where use subjective information and judgment

OUTPUT

-Dollars/quantities
  .Alternatives
  .Recommendations
-Impacts (See Table 3-2.)
-Defensible rationale
-Unified position

REVIEW

-Staff
-Panel
-Board
-Committee
-Exercise leader
-MACOM or DA leadership
-Commanders in Chief (CINC's)
-Decision-maker

DECISION

-Accept recommendation
-Modify recommendation
-Select or modify another option
-Return for further review
-Terminate exercise

Note:
PDIP = Program Development Increment Package
PE = Program Element
SSN = Standard Study Number
MACOM = Major Army Command
DA = Department of Army

Table 3-1. Level 1 Subsystem Menus (Less "Process" Block)

DEVELOPMENT OF OPTIONS

- Sources of options
  - .Human creativity, judgment
  - .Computer-generation/evaluation
  - .Bartering
  - .Logic
  - .Trial and error
  - .Priority lists
- Types of options
  - .Selective funding changes
  - ."Salami slicing" over "eaches," technologies, or functions
  - .Terminations
- Evaluation of options
  - ."Evaluation" menu selections
  - .Interrelations among selections
  - .Intuition

TOOLS

- Computer
  - .Hardware
  - .Databases/spreadsheets
  - .Artificial Intelligence (AI)
  - .Mathematical optimization
  - .Sensitivity analysis
  - .Business practice evaluator
  - .Systems analysis
  - .Graphics/key indicators
  - .War games
- Human
  - .Expert on eaches
  - .Expert on technologies
  - .Expert on functional areas
  - .Boards/panels
- Other
  - .Priority lists
  - .Organizational stands
  - .Threat assessments
  - ."Guiding Principles"
  - .Goals and objectives
  - .Battlefield Development Plan
  - .Nat. Training Center results
  - .Standardized scenarios

EVALUATION

- Technological
- Operational
- Business sense
- Support of goals/objectives
- Support of national strategy
- Agree with priorities
- Agree with "Guiding Principles"
- Agree with logic/common sense
- Political
- Ethical and legal
- Value preferences
- Agree with constraints
- Redundancy of systems
- Equity of resource distribution
- Impacts (both noncumulative and cumulative from other exercises)
  - .Balances (See Appendix 1.)
  - .US training
  - .US doctrine
  - .US deficiencies
  - .Soviet deficiencies
  - .US strengths
  - .Soviet strengths
  - .Soviet planning
  - .US production base
  - .Associated Support Items of Equipment (ASIOE)
  - .Active & Reserve units
  - .Personnel
  - ."Eaches"
  - .OMA resource planning
  - .MCA resource planning
  - .Broad functional areas (See Appendix 1.)
  - .In-house labs
  - .Troop safety
  - .Flexibility
  - .Transportation
  - .Business competition
  - .Technological competitiveness
  - .Public relations
  - .Operating Tempo (Optempo)
  - .Congressional districts
  - .RSI
  - .Overall program stability

Table 3-2. Level 1 "Process" Subsystem Menus

In Table 3-2, the "development of options" menu serves as the driver to initiate and integrate activities that take place within the "tools" and "evaluation" blocks. It is the brain of the "process" block. The "tools" menu includes humans as tools in this process along with computer assets and various other items, such as results from National Training Center exercises. A large number of elements are included in the "evaluation" menu to assist in arriving at well-researched options to offer the reviewers and decision-maker. The choices are further amplified in Appendix 1. Many more items are included than can possibly be fully considered in a single reallocation exercise. The idea is to choose those that are appropriate to the circumstances of the exercise and that are available. Also, this fairly comprehensive list provides a focus for future work that can gradually improve evaluation capabilities.

SIMPLE HYPOTHETICAL EXAMPLE

To demonstrate how the proposed framework could be used in a small-scale reallocation exercise, a simple example is fabricated and shown in Tables 3-3 and 3-4. In this example, the Close Combat Heavy Mission Area must be reduced by $10M in 1990. A personal computer with off-the-shelf mathematical optimization software is selected as a primary tool to develop and evaluate options. The recommended solution is depicted in Table 3-4 as not being totally accepted by the decision-maker and is modified based on his best judgment. Plausible but uncomputed numbers are fabricated and shown for illustrative purposes.

INPUT

- Objective of reallocation exercise:
  Reduce Close Combat Heavy Mission Area procurement by $10M in Fiscal Year 1990 (FY90)
- Strategy for conducting exercise
  - .Maximize resolution of US deficiencies
- Decision-maker is AAE, DA exercise leader is Colonel X supported by 2 staff officers
- Weights for evaluation criteria
  - .Top consideration for overall program stability
- Constraints on exercise
  - .Two-day exercise
  - .Coordination required with affected PEO's & TRADOC
  - .Funding "fenced" for M1A1 Tank

Note:
AAE = Army Acquisition Executive
PEO = Program Executive Officer

TAILORING

- Use personal computer version of mathematical optimization software
- Use 1987 TRADOC contribution values for deficiency resolution
- Use computer to generate options
- Subjectively evaluate reactions of affected congressmen

DEVELOPMENT OF OPTIONS

- Sources of options
  - .Computer-generation/evaluation
  - .Priority list
    - ..Choose 3 candidate systems
- Type of option
  - .Selective funding changes
- Evaluation of options
  - .Operational viewpoint
  - .Business sense
  - .Impacts

Table 3-3. Sample Subsystem Menu Selections & Details, Part 1.

TOOLS

- Computer
  - .Personal computer IBM-AT[1]
  - .POM database
  - ."What's Best"[2] mathematical optimization software
  - .Plots of BDP Deficiency #5 resolution score over time
  - .Score measuring overall program stability
- Human
  - .Experts in Close Combat Heavy Mission Area
- Other
  - .TRADOC priority list
  - .AMC position

EVALUATION

- Operational
- Business sense
- Agree with priorities
- Agree with "Guiding Principles"
- Logic/common sense
- Political
- Constraint satisfaction
- Impacts (both cumulative and noncumulative)
  - .US deficiencies
  - .US production base
  - .Active Component units
  - ."Eaches"
  - .Congressional districts
  - .RSI
  - .Overall program stability

Note:
IOC = Initial Operational Capability
POM = Program Objectives Memorandum

OUTPUT

-Recommend changing $M/Q profiles:

	FY89	FY90	FY91	FY92	FY93
System S1 from:	80/80	82/82	85/85	87/87	90/90
to:	75/75	77/77	80/80	83/83	85/85
System S2 from:	40/80	45/90	50/100	55/110	60/120
to:	35/70	40/80	45/90	50/100	55/110

-Impacts: 6-month delay in IOC of System S2 in Europe, 1-year delay in resolving BDP Deficiency #5. No other significant impacts.

REVIEW

- Assistant Secretary of Army for Research, Development and Acquisition (ASARDA)
- Army Acquisition Executive (AAE)

DECISION

- Modify recommended solution by reducing System S3 by 10% in FY90 to reduce the impact on System S2.

Table 3-4. Sample Subsystem Menu Selections & Details, Part 2.

In this example, the elements in the comprehensive menus of Tables 3-1 and 3-2 have been pared down to a relatively small subset. The blocks in Tables 3-3 and 3-4 show a combination of two types of information: (1) menu elements actually selected and (2) further elaboration on particular elements. For the "input" block, information is made clear and specific in terms of objectives, participants, constraints and driving considerations. Overall program stability has top priority. The "tailoring" block contains details on the use of selected tools and evaluation criteria. Options are to be generated by first using a TRADOC priority list to select three promising decrement candidates and then using computer output to make specific recommendations on these candidates. "Salami slicing" is not acceptable. In the "tools" block, selections include mathematical optimization software, measurement criteria for program stability, and mission area experts. Also included is a plot of how Battlefield Development Plan Deficiency #5 is resolved over time under various reallocation alternatives. (Deficiency #5 might be the inability to acquire a certain target under certain smoke conditions.) In the "evaluation" block, only deficiency resolution, impacts on active component units, and impact on overall program stability are quantified. The remaining considerations, such as impacts on RSI and the production base are made through expert judgment. For this example, these do not change the acceptability of the computer-generated recommendations, which call for changes in only two of the three candidate systems, as shown in the "output" block. The high priority placed on program stability drives such an outcome. The "review" block indicates that review of the recommendation is reserved for the top two people in the Army acquisition chain of command. However, in the "decision" block, this recommendation is modified to include, to a limited extent, a third system in the reduction, with some

small sacrifice in program stability.

Several points are made by this fictitious example. First, it demonstrates that use of the proposed framework need not be cumbersome and that a small number of menu elements may often be adequate. Second, it makes the point that this approach is preferable to using "gut feeling" in executing some vague guidance to "go find $10M." Third, the ultimate modification of the recommended solution shows that slavish following of computer results is not expected and that judgment applied after examining the evidence is very much a part of the framework. Fourth, the ripple effects on both prior and future year procurements show typically strong interrelations within programs over time. Finally, the example indicates the applicability of mathematical optimization to this type of problem. The details of how "optimum" production profiles are obtained that maximize deficiency resolution in minimum time with minimum turbulence to the overall program are presented in the next section.

MATHEMATICAL OPTIMIZATION AS A KEY TOOL

General

From a purely rational and idealistic standpoint, reallocation can be viewed as a mathematical optimization problem. In reality, some elements of reallocation, such as potential impacts on doctrine, do not lend themselves well to expression as numbers. However, others, such as impacts on materiel deficiencies, do. Although in the latter case it makes sense to take advantage of the power of mathematical optimization, little or no use is currently made of this tool for reallocation exercises.

Statement of the Optimization Problem

Given an "objective function" expressed in terms of one or more variables,

the classical mathematical optimization problem is to find allowable values for these variables that will cause the objective function to reach its maximum or minimum possible value. For example, the objective function to be maximized could represent a total score measuring how well deficiencies are being resolved, and the variables could be quantities of various systems to be procured. Allowable values for these variables may be constrained by dollar availability or production capacity. Ideally, the objective function should be "battlefield success." In reality, one is limited to narrower objectives that are as closely allied as possible to battlefield success and that can be reasonably quantified.

Example

Using the example employed to illustrate subsystem menus (pages 22-23), assume that the Close Combat Heavy Mission Area is assessed $10M in FY90. The problem is to determine how that reduction should be taken. The selected strategy is to determine system quantities over a five-year period that will, to the extent possible, maximize elimination of battlefield deficiencies in a minimum amount of time with minimum programmatic turbulence, based on remaining dollars. In this example, the systems chosen to absorb the funding cut are again named S1, S2 and S3 and the corresponding procurement quantities, which can acquire different values for each year, are QS1, QS2 and QS3. For clarity. the problem formulation is partially quantified (using fictitious numbers) and is summarized in Table 3-5.

Based on priorities assigned to Battlefield Development Plan (BDP) deficiencies and the estimated importance of each system to resolving these deficiencies, a contribution value is assigned to each system by TRADOC. Each time an operational unit is outfitted with one of these systems, a certain

Input:

System or ASIOE	Contribution Value for Deficiency Resolution	Buy Objective (units)	MSR (units/year)	MPR (units/year)
S1	9	800	50	100
S2	8	1000	75	190
S3	7	900	55	160
A1		1000	200	500
A2		600	80	100

Objective function = deficiency resolution score minus turbulence score
$= (9xQS1 + 8xQS2 + 7xQS3) - 50x[ABS(QS1-QS1_0) + ABS(QS2-QS2_0) + ABS(QS3-QS3_0) + ABS(QA1-QA1_0) + ABS(QA2-QA2_0)]$, summed over all 5 years

Constraints:

- Production rates. For each year and each system and ASIOE,

  MPR > (QS1, QS2, QS3, QA1, QA2) > MSR

- Dollars available.

  QS1xCS1 + QS2xCS2 + ... + QA2xCA2 <= Total $ available in each year for these systems and ASIOE

- Buy objectives. Summed over all years for each system and ASIOE,

  Total QS1 <= BQS1, Total QA2 <= BQA2, etc.

- Smoothness and shape of production profile. For each system and ASIOE, quantity must not change by more than a given percentage from year to year. Ramp-up and ramp-down years have a larger tolerance.

- Non-negative production quantities.

  (QS1, QS2, QS3, QA1, QA2) >=0

- ASIOE availability.

  QA1 = 4xQS1 + 2xQS2, QA2 = QS3

Output: Optimal buy quantities (QS1, QS2, QS3), by year, needed to most nearly maximize deficiency resolution in minimum time with minimum weighted turbulence. (Illustrative results given in Table 3-4.)

Table 3-5. Example Mathematical Optimization Problem

percentage of the associated deficiency is removed. From the product of these two numbers, for each system S1 fielded, the resulting contribution value for deficiency resolution is assumed here to be 9. These numerical scores per unit quantity are given as input in this example. Also provided is information about restrictions on maximum numbers of each system legally procurable in a given year and minimum (MSR) and maximum (MPR) production capabilities.

The contribution toward resolving deficiencies in a given year for a given system is obtained by multiplying production quantity by the deficiency resolution score per unit quantity. A combined score for deficiency resolution is the sum of such products over all systems and all years. To increase this score, quantities can be adjusted. However, each change in quantity originally planned for procurement represents a degree of turbulence to the overall program. From Table 3-4 in the FY90 column, original quantities for that year are $QS1_0=82$, $QS2_0=90$, etc. A very simple measure of turbulence is taken as the sum of all quantity changes for systems and ASIOE for all 5 years. These changes are the absolute value of the difference between original and proposed quantities. (A more sophisticated measure is certainly possible, but this one is reasonable and easily implemented.) A weighting number (50) is used to multiply the turbulence score in order to reflect guidance that program stability is of top priority. Minimizing the time over which deficiencies remain unresolved can be treated in a number of ways. For example, a "penalty function" can be incorporated in the objective function that subtracts increasingly larger numbers from the overall score with each succeeding year of production. Based on experimentation with "What's Best,"[3] such an explicit action to minimize deficiency resolution time is normally unnecessary. A total score comprised of a deficiency resolution score and a negative turbulence

score is taken as the objective function to be maximized.

A number of constraints restrict the allowable values for the system quantities. Each system and ASIOE must be manufactured at a rate greater than or equal to the Minimum Sustaining Rate (MSR) and less than or equal to the Maximum Production Rate (MPR), above which new manufacturing facilities are required. Total costs for these systems (CS1, CS2, etc.) must not exceed dollars available in any given year. Further, established total buy objective quantities (BQS1, BQS2, etc.) for each system must not be exceeded. Production profiles must be reasonably smooth, with no internal "holes" (zero procurement quantities) and a smooth ramp-up and ramp-down. Negative procurement quantities are meaningless and must be explicitly excluded. Finally, ASIOE must be available in the quantities and at the time required. As shown, each S1 requires four A1's, each S2 requires two A2's and each S3 requires one A2.

The problem can now be solved with a personal computer, e.g., IBM-AT, with commercial off-the-shelf optimization software. The results are optimum procurement quantities by year for five years that provide the best possible compromise among deficiency resolution, time and programmatic turbulence, in accordance with the weights assumed for relative importance of these factors.

Other Applications

The mathematical optimization tool can be helpful in many cases where quantifiable objectives and constraints must be satisfied. For example, one may wish to minimize some of the other impacts listed in the "evaluation" menu of Table 3-2. Quantification of negative impacts would allow direct minimization of penalties associated with funding decrements. Selected balances among mission areas or other functional areas, such as armor and antiarmor, could be

maintained in the face of funding decrements with the help of this tool. By relating US systems to Soviet deficiencies, one could make predictions on how to maximize exploitation of their deficiencies. (This is one way to implement the largely neglected Guiding Principle #2 in Chapter II, page 13.) Also, battlefield flexibility could be maximized if appropriate quantitative criteria are developed for use with this tool. As alluded to in the example shown, a number of objective functions, say OF_1, OF_2 and OF_3, can be combined into an overall objective function using judgmental weights of relative importance such as $W_1=4$, $W_2=3$ and $W_3=2$. The problem is then to maximize:

$$OF_{total} = W_1 x OF_1 + W_2 x OF_2 + W_3 x OF_3 = 4 x OF_1 + 3 x OF_2 + 2 x OF_3.$$

Employment Considerations

An optimization problem is either linear or nonlinear depending on the mathematical structure of the objective function and constraints. If the variables appear in linear combinations, the problem is known as a linear programming problem and is solvable through the Simplex Algorithm[4] or a recently developed fast algorithm for large problems, Karmarkar's Algorithm.[5] Nonlinear programming problems occur if, for example, the deficiency resolution score or one of the constraints depends on the product of two production quantities. Most available software is designed to solve the linear problem. The nonlinear problem is more difficult, and global maximum or minimum solutions are guaranteed only under certain conditions. However, in reallocation problems, it is desirable but not necessary to find the global maximum or minimum of an objective function. Any improvements in the objective function can be useful. Consequently, many simple computerized search procedures well established for nonlinear problems may be adequate.[6]

Because of computer speed limitations, an IBM-AT class of computer can

deal practically with probably no more than about twenty-five systems simultaneously in a linear optimization problem. Computation time increases dramatically with number of systems. If hundreds of system quantities are to be simultaneously optimized, a mainframe computer or even a Cray supercomputer may be necessary. The Army has ready access to these tools.

ENDNOTES

1. IBM is a registered trademark of the International Business Machines Corp.

2. Computer program. Copyright by General Optimization Inc.

3. General Optimization Inc., 2251 N. Geneva Terrace, Chicago, IL 60614, Telephone (312) 248-7300.

4. US Army Materiel Command, AMC Pamphlet AMCP 706-192, pp. 3-8 to 3-12.

5. Andrew M. Rockett and John C. Stevenson, "Karmarkar's Algorithm," BYTE, Vol 12, No 10, September 1987, pp. 146-160.

6. US Army Materiel Command, AMC Pamphlet AMCP 706-192, pp. 4-1 to 4-35.

CHAPTER IV

IMPLEMENTATION CONSIDERATIONS

The proposed framework appears to add complexity to the already extremely complicated PPBES. However, any such increase is totally controllable through the menu selection and tailoring processes. Complexity growth can vary from none to substantial, depending on the tools and evaluation criteria chosen for a given situation. Better indicators using composite evaluation scores and graphics[1] can make most of the complexity transparent to the decision-maker. Improved rationality sometimes has a price as well as benefits. Wisely controlling where and how to achieve it will determine when it is a bargain and when it is not.

GENERAL

Clearly the proposed framework is flexible and broad enough to be implemented immediately with current tools. In the most conservative or base case, it does little more than provide additional structure, justification and perspective to current procedures. However, as more and more of the "process" menu elements (page 20) are brought into play, reallocations should become increasingly rational, defensible, and less disadvantageous to warfighting capabilities. At the same time, the methodology also becomes increasingly suitable for initial allocation as well as reallocation.

Implementation of the framework could also provide additional focus and justification for the development of improved tools, evaluation criteria and ways to generate options. For example, an Army corporate database, improved wargaming capabilities and possibly supercomputers are clearly useful in the context of this framework.

Implementation could be aided by a number of ongoing database efforts. One of these is the comprehensive Acquisition Information Management (AIM) program being developed at the Army Materiel Command to "provide a responsive information network to support the overall Army acquisition management mission."[2] Another such effort is the AMC/TRADOC Mission Area Materiel Plan (MAMP) database.

Chances for successful implementation could be enhanced if decision-makers were to ask specifically for and make use of recommendations developed with tools and evaluation criteria from the proposed framework. A way to institutionalize this or some modified reallocation framework is to reference it in Army Regulation AR70-1 ("Systems Acquisition Policy and Procedures"), AR 1-1 ("Planning, Programming, Budgeting, and Execution System") and the AMC-TRADOC Materiel Acquisition Handbook [28].

Guidelines

In tailoring the reallocation approach, the choice of tools and evaluation criteria will be highly dependent on whether the reprogramming issue involves the execution, budget, program, or planning years. For example, execution-year issues will largely revolve around Congressional reprogramming rules, obligation rates and other business sense considerations. Greater freedom to adjust programs is generally available in programming and planning years. The choices will also depend on the time and tools available for the exercise. Degree of formality in using the framework should be linked to scope of the effort required. Where possible, especially for more important exercises, some of the system blocks, particularly those for input and tailoring, should be written out in detail. Such records, in addition to their value as coordination

instruments, provide a valuable audit trail for future exercises and for explaining why certain actions were taken.

ENDNOTES

1. Edward R. Tufte, The Visual Display of Quantitative Information, pp. 139-160

2. "Reorganizing the Army Acquisition Structure - An Interview with LTG Jerry Max Bunyard." Army RD&A Bulletin, September-October 1987, pp.1-4.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The major result of this study is a rational framework that is broad, flexible and basically logical. Its practicality largely depends on the wisdom with which the menu selection and tailoring processes are carried out to meet individual circumstances and on the availability of suitable tools. Its effectiveness depends on the quality of the elements in the "process" subsystem menus. Specific conclusions concerning the framework are presented in this chapter. Also, recommendations are made regarding implementation of the general framework and of specific menu elements.

CONCLUSIONS

- Proposed framework provides focus and justification for development of improved tools and evaluation criteria for funding reallocation problems.
- Extensiveness of the framework menus indicates the breadth of possibilities, challenges and opportunities for improving the reallocation process within the "structured" system as opposed to the "unstructured" system (page 7).
- Proposed evaluation process emphasizes understanding of many types of broad impacts and interrelations among systems.
- Many useful tools already exist to support rational reallocation decisions. Others need to be developed, particularly in the area of evaluating impacts.
- Many of the framework elements are potentially applicable to the initial resource allocation problem.
- Use of the framework should help promote discipline in the reallocation process.

• Similar frameworks can be developed for other funding categories, for use at other organizational levels and for the resource allocation problem.

• Use of mathematical optimization has strong potential to increase rationality in funding reallocation and to minimize negative impacts from funding reductions.

• The elements of the proposed framework system model can be used as a blueprint for action to help improve the reallocation process.

RECOMMENDATIONS

Regarding the General Framework

• Implement the proposed framework at DA, AMC and TRADOC and steadily improve it over time through the periodic addition of new tools and evaluation capabilities.

• Obtain consensus and DA approval for the proposed (or improved) Guiding Principles (Table 2-1, page 13) that are specific enough to be useful in materiel reallocation exercises.

• Conduct an analysis of benefit vs. effort for each menu element and then prioritize framework development tasks.

• Obtain contractor support to build up a collection of tools that can enable the evaluation of alternatives in terms of selected evaluation criteria from Appendix 1.

• Top management should demand better information with which to make reallocation decisions and thereby spur development of improved tools, procedures and indicators. In particular, information about impacts selected from the "evaluation" menu and Appendix 1 should be required.

Regarding Use of Specific Menu Elements

• Assign personnel at AMC, TRADOC and DA to track deficiencies per se and how well each is being addressed by current programs. Despite the fact that the materiel thrust of PPBES is deficiency resolution, relatively little effort is currently made to insure that each deficiency is being attacked by the necessary set of programs. Rather, each program is now largely assessed in isolation as to the degree it addresses one or more deficiencies. Assumption of a more "top-down" rather than "bottom-up" viewpoint is needed.

• Initiate an effort aimed at giving increased emphasis on Guiding Principle #2, page 13, to determine Soviet Battlefield Development Plan deficiencies and to proceed aggressively with programs that exacerbate them. (Top-attack munitions developed for use against vulnerable areas on Soviet vehicles illustrate this idea.)

• Develop a preprogrammed, virtually turnkey operation for producing standardized graphics and key indicators from a menu of choices so as to provide a broad, meaningful picture of reallocation impacts.

• Decision-makers should normally make judgments on "eaches" only after looking at the "broad picture" including a number of selected impacts (not just one).

• Establish a DA/AMC thrust to make use of reallocation tools based on Artificial Intelligence (AI) and mathematical optimization, including use of a Cray supercomputer, if needed.

• Develop and apply improved measurement/scoring techniques for technical risk, contributions to battlefield flexibility, and overall program turbulence.

• Use existing tools and databases to the maximum extent possible, rather than proliferate databases.

• Use the Acquisition Information Management (AIM) system and the Mission Area

Materiel Plan (MAMP) database as key framework tools.

- Develop the necessary database integration to allow the determination of impacts on specific fielded units over time as reallocation alternatives are explored.
- Initiate a special effort to search for instances of overkill, such as too many antiarmor systems addressing the same target.
- Make explicit use of principles, goals, and objectives to guide reallocations.
- Develop sensitivity analysis tools to determine how strongly evaluation indicators are affected as funding levels are systematically changed and how strongly computer results depend on assumptions and weighting factors.
- For each reallocation exercise, obtain up-front agreement among participants on details of input to and tailoring of the reallocation process.
- Focus primarily on the Management Decision Package (MDEP)[1,2] level of detail.
- Develop the necessary database integration to account for ASIOE for each system.
- Develop sophisticated computerized business-sense filters to surface questionable programs deserving of further individual scrutiny and potential use as bill payers.
- Further develop "smart" spreadsheets that can determine funding implications of changing program milestones.

ENDNOTES

1. Bunnie Smith, "Refocusing Resource Management - Stage 2," Resource Management Journal, Winter 1985, p. 9.

2. Barry S. Baer, "Helping Management Make Better Use of Resources to Achieve the Army's Desired Outputs," Resource Management Journal, Winter 1985, pp. 22-25.

BIBLIOGRAPHY

1. A Study of Resource Allocation on the Army Staff. Office of the Chief of Staff, US Army, Pentagon, Washington, D.C., 14 July 1978.

2. Baer, Barry S. "Helping Management Make Better Use of Resources to Achieve the Army's Desired Outputs." Resource Management Journal, Winter 1985.

3. Cooper, Leon and Steinberg, David. Introduction to Methods of Optimization. Philadelphia: W.B. Saunders Company, 1970.

4. Costello, Robert B. "Acquisition Reform Moves Front & Center." Defense 88, January-February 1988.

5. Easton, Allan. Managing for Negative Growth. Reston: Reston Publishing Company, Inc., 1976.

6. Lyden, Fremont J. and Miller, Ernest G., eds. Planning programming Budgeting - A Systems Approach to Management. Chicago: Markham Publishing Company, 1972.

7. Harrison, E. Frank. The Managerial Decision-Making Process, 2nd Edition. Boston: Houghton Mifflin Company, 1981.

8. Ikle, Fred C. et al. Discriminate Deterrence - Report of the Commission on Integrated Long-Term Strategy. Washington: Government Printing Office, January 1988.

9. Kepner, Charles H. and Tregoe, Benjamin B. The New Rational Manager. Princeton: Princeton Research Press, 1981.

10. Koontz, Harold, O'Donnell, Cyril, and Heinrich, Heinz. Management. New York: McGraw Hill Book Company, 1980.

11. Kotz, Nick. Wild Blue Yonder. New York: Pantheon Books, 1988.

12. Lee, Alec M. Systems Analysis Frameworks. New York: John Wiley & Sons, Inc., 1970.

13. Lloyd, Richmond M. and Lorenzini, Dino A. "A Framework for Choosing Defense Forces." Naval War College Review, Jan - Feb 1981.

14. Pearce, David. "The PPBE System and the Real System." Resource Management, Vol 7, No 4, December 1986.

15. Reed, Leon S., Dickson, Brian, and Hodge, Francis P. Resource Management: An Historical Perspective. Arlington: The Analytic Sciences Corporation, 31 December 1984.

16. "Reorganizing the Army Acquisition Structure - An Interview with LTG Jerry Max Bunyard." Army RD&A Bulletin, September-October 1987.

17. Rockett, Andrew M. and Stevenson, John C. "Karmarkar's Algorithm." BYTE, Vol 12, No 10, September 1987.

18. Schemmer, Benjamin F. "An Exclusive AFJ Interview With: Phillip A. Karber." Armed Forces Journal International, June 1987.

19. Smith, Bunnie. "Refocusing Resource Management - Stage 2." Resource Management Journal, Winter 1985.

20. Surveys of Economic Theory - Volume III: Resource Allocation. London: MacMillan and Company Limited, 1967.

21. The Random House Dictionary of the English Language, 2nd edition, unabridged. New York: Random House, 1987.

22. Tufte, Edward R. The Visual Display of Quantitative Information. Cheshire: Graphics Press, 1983.

23. US Army Command and General Staff College. Reference Book 25-1. Resource Planning and Allocation. Washington: Government Printing Office, July 1983.

24. US Army Intelligence Agency, Intelligence and Threat Analysis Center. Soviet Battlefield Development Plan, Vol I, Soviet General Doctrine for War (U). AIC-WP-2660-074-87-Vol I, June 1987.

25. US Army Materiel Command. AMC Pamphlet AMCP 706-192. Engineering Design Handbook - Computer Aided Design of Mechanical Systems. Alexandria: July 1973.

26. US Army Training and Doctrine Command, ATCD-AM. Battlefield Development Plan 1985 (BDP 85). Gov't Accession Number AD-C953539L. FT. Monroe: 26 December 1985.

27. US Army Training and Doctrine Command, ATCD-AM. Battlefield Development Plan 1986 (BDP 86) Deficiencies. FT. Monroe: March 1987.

28. US Army Training and Doctrine Command. TRADOC Pamphlet 70-2. Materiel Acquisition Handbook. FT. Monroe: 1987.

29. US Army Training and Doctrine Command. TRADOC Regulation 11-15. Concepts Based Requirements System. FT. Monroe: 4 August 1988.

30. US Department of the Army. Army Regulation 1-1: Planning, Programming, Budgeting, and Execution System. Washington: 9 July 1986.

31. US General Accounting Office. The Department of Defense's Planning, Programming, and Budgeting System. GAO/OACG-84-5. Washington: US GAO. September 1983.

APPENDIX 1

LEVEL 2 "EVALUATION" MENU

-Technological
 .Technical risk
 .Overlap with "black" programs
 .Ease of developing countermeasures
 .Technological surprise
-Operational
 .Contribution to AirLand Battle
 .War game results
 .Compatibility with TRADOC/DCSOPS operational priorities
 .CINC priorities
 .Risks of operational failure
 .Nat. Training Center results
-Business sense
 .Adequate funding wedges in out-years
 .Shape of production profile
 .Economic buy quantities
 .Cost vs. value
 .Upgrades of current equipment at relatively low cost
 .Obligation rates
 .Expenditure rates
 .Funds that can be legally added to a program ("headspace")
 .Efficiency
-Support goals/objectives
 .Expressed as an objective function for mathematical optimization
 .Expressed in qualitative terms
-Support national strategy
-Agree with priorities
-Agree with "Guiding Principles"
-Agree with logic/common sense
-Political
 .Congressional
 .OSD
 .DA
 .CINC
 .JCS
 .White House
-Ethical and legal
 .Geneva Conventions
 .Previous Army commitments or statements
 .Compliance with law
 .Compliance with regulations
 . Agreement with Congressional committee language
-Value preferences
 .Experience based
 .Judgment
 ."Gut feeling"
-Agree with constraints
-Redundancy of systems
 .With other Army systems
 .With other service systems
 .With allied systems
-Equity (fairness) of resource distribution (Normally to be discouraged as a criterion)
-Impacts (both noncumulative and cumulative from other exercises)
 .Balances
  ..LIC vs. MIC vs. HIC
  ..Armor vs. antiarmor
  ..Among PEO's
  ..Light vs. heavy forces
  ..Overall US vs. Soviets
  ..Close vs. rear vs. deep battle
  ..PIP vs. new development
  ..Offense vs. defense
  ..Mission Area vs. Mission Area
 .US training
 .US doctrine
 .US deficiencies
  ..Dates when deficiencies will be fully corrected
  ..Funds applied to each deficiency
  ..$ vs. deficiency priority
  ..US systems vs. Soviet systems
  ..US functions vs. Soviet functions
  ..US technologies vs. Soviet technologies
  ..US quantity vs. Soviet quantity
  ..US quality vs. Soviet quality
 .Soviet deficiencies
 .US strengths
  .."Competitive Strategies"
  ..Relative funds applied toward

strengths vs. deficiencies
..Expected Soviet costs to counter
.Soviet strengths
.Soviet planning
..Reactions to uncertainties about US intentions and capabilities
..Need for expensive and difficult countermeasures
.US production base
..Surge capabilities
..Sustainability
..Small arms
..Tanks
..Aircraft
..Ammunition
..Missiles
.. Other
.Associated Support Items of Equipment (ASIOE)
.Active & Reserve units
..Individual units
..Units in general
.Personnel
..Numbers in each MOS
..Proficiency levels
."Eaches"
.."Big ticket" items
..High-visibility items
..Program milestones
.OMA resource planning
.MCA resource planning
.Broad functional areas
..Four Pillars of Defense
..Five Key Operational Capabilities (KOC's)
..Twenty-six TRADOC "functional packages," e.g., C2, deep attack, target acquisition, personnel/equipment survivability, NBC, munitions, missiles, mobility/counter mobility, training support
.In-house labs
.Troop safety
.Flexibility
..Minimize effects of technological surprise
..Ability to use allied or enemy supplies
..Unexpected conditions during war
. Transportation
..Sealift
..Airlift
..Soldier's load
..Combat unit's weight
..Transportation equipment
.Business competition
.Technological competitiveness
..Ability to achieve technological surprise
.Public relations
..Cumulative effect on a given type of safety issue
..Better individual equipment in another service or country
..Value for the money
..Gold plating
..Clear requirement
..Risk of embarrassing failure
.Operating Tempo (Optempo)
.Congressional districts
.RSI
..Among allies
..With enemy
..Among US services
..Among systems
..Among reserve and active forces
.Overall program stability

Note:
LIC = Low-Intensity Conflict
MIC = Mid-Intensity Conflict
HIC = High-Intensity Conflict
PIP = Product Improvement Program
DCSOPS = DA Deputy Chief of Staff for Operations
MOS = Military Occupational Specialty
C2 = Command and Control

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